

8. Notes on the Collection of Specimens of the Genus *Millepora* obtained by Mr. Stanley Gardiner at Funafuti and Rotuma. By Professor SYDNEY J. HICKSON, M.A., F.R.S., F.Z.S.

[Received October 4, 1898.]

This collection consists of a dozen large dried coralla and several smaller pieces and fragments, together with nearly three dozen pieces of different forms of growth preserved in spirit.

As I have already pointed out in a communication to this Society, there is no reason to suppose that there is more than one species of this genus, but there are nevertheless several characters of interest presented by specimens from different coral-reefs which are deserving of record. I propose to use the term "Facies" for the general form of growth of the specimens described, and to retain as far as possible under this term the names previously used for species.

I. *The dried Coralla.*

MILLEPORA ALICORNIS L.

Facies "*ramosa*."

There are several specimens in the collection which under the old system would have been placed in the species *Millepora ramosa* Pall.

The principal features of this facies are that the branches are thick and usually cylindrical, anastomosing freely below, but having at the extremities a number of free obtusely pointed branches.

One of the most interesting specimens of this facies was obtained at the S. entrance in Funafuti, at a depth of 7 fathoms. The stem divides into branches in a vertical plane, which freely anastomose, forming a wide-meshed network 10 inches in height. The main stem is nearly an inch in diameter and the principal branches of it are on an average $\frac{1}{2}$ an inch in diameter.

The colour of the corallum is pale yellow. There are no parasitic barnacles on any of the branches of this specimen, but the Gastropod, *Calliostoma similaris* (Reeve), and the Pelecypod, *Avicula formosa* (Reeve), were found adhering to the specimen.

The genus *Millepora* being regarded as an essentially shallow-water form, collectors rarely give the depth at which their specimens were obtained, and we have in consequence very little information concerning its bathymetrical range.

Tenison-Woods says that *Millepora undulosa* occurs in 20 fathoms in Foveaux Straits, Moore and Smith found living *M. ramosa* in 15 fathoms, and Gardiner obtained the specimens here recorded in 7 fathoms¹. These are the only statements I can find giving a definite range beyond low-tide mark.

¹ Mr. Gardiner's notes on the localities of the facies "*ramosa*" are as follows:—"It grows very abundantly immediately outside the deep channels to the S.E. and N.W. of the Atoll Funafuti. I also obtained it off Pava. In the

Some doubt may be felt as to whether the coral collected by Tenison-Woods was really a *Millepora*. The description given of it is not sufficiently detailed to give great confidence in the belief that a Millepore exists in deep water so far south as the Foveaux Straits; but there can be no doubt whatever about the other two statements; and it is interesting to note that in both cases in which Millepores have been dredged at a depth well below low-water mark, *i. e.* in places where the growth in height cannot be limited by exposure to the air, the facies is "*ramosa*." Moseley says that *M. ramosa* "appears to thrive best in the shade"¹.

The yellow colour of the corallum of the Funafuti specimens from 7 fathoms is in accordance with the statement made by Forskål that the species *M. dichotoma* "*inhabitat profundum*," and is of a "*color flavicans*," *M. dichotoma* being regarded as a synonym of *M. ramosa* by some authors. But the yellow colour is not confined to deep-water forms, nor to forms of this facies, for Moseley says that the *Millepora nodosa* from Tahiti, found in one or two feet of water, is of a bright yellow colour, and Mr. Gardiner tells me that a species coloured orange-brown was fairly common on one shoal to the windward side of the lagoon at Funafuti. It is possible, however, that the white bleached coralla occurring on many reefs are confined to the shallow water and that in a few fathoms of depth all the Millepores are naturally yellow.

There is another piece of corallum in Mr. Gardiner's collection which must be included in this facies, which is of interest as being found in shallow water and showing a flattening and expansion of the branches, which if it were carried a little further would lead to the formation of plates. Millepores living in very shallow water cannot grow to more than a certain height, and their growth upwards is checked and stopped by the low tides. It is probable that a lateral expansion of the branches follows any check to the growth given to the distal extremities, and that ultimately the broadened branches fuse together to form lamellæ or plates.

The diameter of the mouth of the gastropores on a medium-sized branch of this form is, on taking an average of 12, found to be 0.276 mm.

Facies "*esperi*."

A specimen in the collection $6\frac{1}{2}$ inches in height, springing from a basis $2\frac{3}{4}$ inches $\times$ 7 inches, from shallow water, S. passage, Main Island, Funafuti, agrees most closely with the description given of *Millepora esperi* by Duchassaing and Michelotti. The form of the corallum is not unlike that assumed by large specimens of

lagoon it occurs only near the deep channels. It occurred in 7 fathoms of water off the entrance between Falefatu and Mateika." Mr. Gardiner also believes that he obtained small pieces of *Millepora* in 20 fathoms off the N. entrance near Pava, and in 30 fathoms off Falefatu; but as there is just a possibility that the pieces observed may have remained sticking to the swab from a previous dredging, he does not wish me to consider the evidence to be conclusive.

¹ H. N. Moseley, "Notes of a Naturalist on the 'Challenger,'" p. 27.

Alcyonium digitatum, being thickly palmate with short obtuse and warty branches.

The most striking feature about this Millepore, and fragments of others which I judge must have had a similar form, is the great thickness of the "live" corallum. The apparent thickness of Millepore branches is often very misleading, for it may be observed that in many specimens the apparent thickness is due to the Millepore having grown over a dead coral and completely encrusted it.

Some of the branches of this coral are actually more than 22 mm. in diameter. They are the thickest branches of live Millepore corallum I have had the opportunity of examining.

I have satisfied myself that in most cases the pores are continuous from the surface to the centre without any break but that of the tabulæ. In some of these pores there must be at least 35 tabulæ, which is more than twice as many as in any other Millepore I have carefully studied.

The texture of the corallum is light and brittle, the colour white, and the surface almost free from barnacles and worm parasites.

All of these features suggest that the conditions under which these specimens lived were particularly favourable, that the growth of the corallum was rapid, and the conditions of its tissues so healthy that it could resist the action of the larvæ of parasites.

Mr. Gardiner tells us that *Millepora* of the facies "*esperi*" occurs most abundantly in the lagoon on each side of the passages to windward, and never where it would be directly exposed to the rush of the tide. In this situation it forms large clumps, commonly as much as 7 or 8 feet in diameter, rising out of 5-10 feet of water to a foot from the surface at ordinary low tide. It also occurs sparingly by the passages to leeward, and on some of the more exposed shoals in the lagoon.

The lightness and brittleness of these specimens form a very striking feature, and it occurred to me that it might be expressed in figures fairly accurately by the specific gravity, which was found to be 2.53. Compared with other Millepores this is decidedly low. The sp. gr. of a fragment of facies "*ramosa*" was 2.9, of a complanate form from Funafuti also 2.9, of a complanate form in the Manchester Museum 3.17.

Facies "*complanata*."

There is one large specimen, 20 cm. in height, which resembles the form of growth of *M. complanata*, and there are several fragments similar to it in the collection. Mr. Gardiner says it is not common in the lagoon, being found only on certain shoals close together towards the E. side.

The large specimen consists of five coalescent laminæ, the free edges of which are divided in some places into short, blunt digitations or tubercles. The thickness of the laminæ varies considerably, but the average thickness is about 1 cm. The average number of

tabulæ in each pore is about 17. The specimen appears to have been in a very sickly condition when taken. More than $\frac{2}{3}$ of one face of it is dead coral, and the other face is considerably attacked by Algæ. Nearly the whole of the "live" surface is pitted with *Pyrgoma milleporeæ*. In one place I counted no less than 13 young cirripedes in an area $1 \times 1\frac{1}{2}$ centimetres.

On the surface of a fragment which was probably broken off this specimen there may be seen several ampullæ.

The specimens of *Millepora* collected by Mr. Gardiner in Rotuma are of two kinds. They were found only in the boat-channel, there being none on the reef. One of these consists of coralla of light texture, of branching habit, similar to that usually considered characteristic of *Millepora alcornis*. The branches are disposed in a single plane and freely anastomose, their average thickness being about 5 mm. They are free from parasitic cirripedes and show on some of the branches numerous ampullæ.

The other kind consists of very hard dense coralla, partly or wholly encrusting dead coral, but as the free edges rise into plates with crested borders they correspond most closely with the species *M. plicata*. Hence they may be considered under the term facies "*plicata*." The thickness of the live corallum is rarely more than 3 mm. from each surface, and its great hardness affects the manner of its fracture in such a remarkable way that great difficulties present themselves when an attempt is made to count the tabulæ in each pore. From the (small) number of pores I have been able to examine, I arrive at the conclusion that there cannot be on an average more than five tabulæ in each.

One of these specimens shows the scars of numerous ampullæ.

The surface of all these forms from Rotuma is remarkably clean and free from parasites of all kinds.

The remarkable hardness of the corallum makes the pores very apparent, and gives them the appearance of being much larger than they really are. On first handling the specimen I thought the pores were the largest I had seen, but on measuring the diameters of 12 gastropores on one face of a specimen I found the average to be only 0.27 mm., and on the opposite face the average of five or six which I measured was less than 0.2 mm. These figures show how deceptive estimates of size may be which are made by unassisted vision. The pores of the facies "*plicata*" from Rotuma are actually smaller than those of the facies "*ramosa*" from Funafuti, and yet they have very decidedly the appearance of being larger.

The remarkable difference in size between the gastropores on one face of the corallum and on the other which is recorded above is by no means exceptional. In nearly every case in which I have compared the average diameter of 12 gastropores from one part of a corallum with an average of 12 on another I have found a certain difference. It is probably to be accounted for by the difference in food-supply, fresh water, or other external conditions

to which the different parts of a colony are exposed in their natural position on the reef.

II. *Spirit-specimens.*

Facies "*ramosa*."

Mr. Gardiner killed in corrosive sublimate and preserved in spirit some specimens of this facies which he obtained in 7 fathoms of water at Funafuti. It was clearly of importance to see if the soft parts of the deep-water ramose forms differ in any degree from the shallow-water lamellate forms.

I found the material in excellent condition for the investigation, as many of the gastrozooids appeared to be fully expanded, and some of the dactylozooids partially so, and I was able in consequence to see in a particularly favourable manner the small and large nematocysts, the tentacles, and the histology of the polyps.

The nematocysts are, so far as I can judge, exactly the same as in all other Millepores. I have been unable to find any of the large kind exploded in my preparations, and consequently I can say nothing about the character of the thread. The condition of these large nematocysts varies considerably in different specimens of Millepores; sometimes they may be found in all stages of development, but more frequently they are nearly all in one stage. Sometimes nearly all the ripe nematocysts of this kind may be seen with their threads attached to them, sticking into the superficial ectoderm or just below it; in others, again, not a single exploded nematocyst can be found. In the specimens I am now describing the absence of exploded nematocysts may be accounted for by believing that they were washed off in coming up in the dredge, but I am not certain that that explanation is quite satisfactory. The unexploded nematocysts measured $\cdot 02$ mm. $\times$ $\cdot 025$ mm., *i. e.* the exact size of the large nematocysts of other Millepores. The manner in which the thread is coiled up inside the vesicle is also the same as in other Millepores.

The small kind of nematocyst which is found characteristically in the tentacles of gastrozooids, but occurs also more rarely in the cœnenchym, varies in size considerably, but the largest of them are exactly $\frac{2}{3}$ the length of the large kind of nematocyst, and are consequently normal in size. In one instance I have seen the swollen base of the thread armed with three spines, as described and figured by Moseley. There is no reason, therefore, to suppose that the nematocysts of this form differ from those of other Millepores.

As in all other specimens I have examined, the canals contain numerous zooxanthellæ. They are a good deal more crowded than usual in the superficial canals, as might be expected in forms living in deeper and consequently darker water. Each zooxanthella is perfectly spherical in form, being $\cdot 0125$ mm. in diameter. They exhibit no peculiar features.

The gastrozooids and dactylozooids are exactly the same in all essential features as the gastrozooids and dactylozooids of other well-preserved Millepores which I have examined.

Facies "*complanata*."

The spirit-specimens of this facies were collected in shallow water at Funafuti, and are, like the dried specimens, very considerably affected by barnacles and other parasites. Unfortunately the state of preservation was not perfect, and many details of histology could not be made out at all.

The preparations are, however, of very great interest, as showing medusæ bearing spermacytes. Many of the medusæ are quite loose in their ampullæ, and are shaken out of them during decalcification, so that they can be mounted whole. The largest medusæ mounted in this manner were about .57 mm. in diameter; but as it is impossible to prevent them from being slightly compressed as the Canada balsam dries, we may consider that their diameter is only a little over $\frac{1}{2}$ mm. This is almost exactly the same size as the male medusæ in Professor Haddon's collection.

Facies "*plicata*," from Rotuma.

Several specimens of this form were killed in corrosive sublimate, washed with iodine, and preserved in spirit. They are all in an excellent state of preservation.

Many of the specimens show on the surface shallow round depressions about $\frac{1}{2}$ mm. in diameter, which so closely resemble the scars of the ampullæ seen on the dried coralla, that there can be no doubt that they represent the spaces from which the medusæ have escaped. The depression is, however, overgrown by ectoderm and possibly a certain amount of the endoderm's canal-system as well, so that when the specimens are decalcified all trace of these depressions disappear. In studying the ampullæ of dried coralla I was much struck with the fact that they are never found anywhere but in the superficial layer of the corallum, and I was inclined to believe at one time that when the colony of a Millepore had once produced medusæ it died. This view, however, was not confirmed by the examination of Prof. Haddon's material from Torres Straits, in which the medusa-bearing colonies showed every sign of being in a thoroughly healthy and actively feeding condition.

The Millepores from Rotuma confirm the opinion that my former view was wrong, since several of the gastrozooids contain food in the form of minute Crustacea, and the ectoderm and other tissues are all thoroughly sound and healthy. The specimens prove, moreover, that when the outer wall of the ampulla is broken to allow the escape of the medusa, the cœnosarcial tissue covers over the gap, and in time obliterates all signs of it.

It is quite impossible, of course, to form any estimate of the length of time that elapsed from the escape of the medusæ until the specimen was collected, but it is noteworthy that not a single medusa remains. I have decalcified more than three quarters of the material sent to me, and have searched through the whole of the material thus decalcified with a powerful lens, but I can find no trace of a medusa, and in the sections I have cut there are no signs of any sexual organs.